Objective: To assess duration of excessive crying and its relation to sleep and eating disturbances in a population sample of infants.

Design: Cross-sectional study.

Setting: Random digit-dialing survey, enrolling birth cohorts between 1999 and 2003, in Germany.

Participants: Children aged 4 years and younger.

Main Exposures: Excessive crying, retrospectively ascertained according to modified Wessel’s criteria, and duration of excessive crying.

Main Outcome Measures: Severe eating or sleeping problems at interview.

Results: The participation rate in the random digit-dialing survey was 62%. The analysis was confined to 1865 children with complete data. The observed prevalence for excessive crying ever was 16.3% (95% confidence interval [CI], 14.7-18.1), beyond 3 months 5.8% (95% CI, 4.8-6.9), and beyond 6 months 2.5% (95% CI, 1.9-3.3). Excessive crying only in the first 3 months did not increase the prevalence of sleep or eating disturbances whereas crying beyond 6 months did; prevalence of eating disorders was 19.1% (95% CI, 9.1-33.3) and prevalence of sleeping disorders was 12.8% (95% CI, 4.8-25.7) compared with 2.7% (95% CI, 1.9-3.6) and 3.6% (95% CI, 2.7-4.6), respectively, in children without excessive crying.

Conclusions: Persistence of crying beyond the first 6 months heralded a higher prevalence of eating or sleeping difficulties in children with excessive crying than in children without excessive crying. These parents should be offered support and counseling over a broader spectrum of features related to multiple regulatory problems.

EXCESSIVE CRYING IS A COMMON condition in infants which may interfere with the mother-infant, father-infant, and mother-father interaction and may increase the risk of child abuse. Prevalence estimates vary depending on the case definition used. Most articles use modifications of Wessel’s “rule of three” (excessive crying for 3 hours per day, 3 days per week, for 3 weeks) to define excessive crying. Although excessive crying is often limited to the first 3 months of life, there is a substantial proportion of children in whom excessive crying persists beyond the third month. In clinical settings, persistent crying may be associated with other features of multiple regulatory problems and constitute a severe threat to the developing mother-child relationship, and some articles point to interdependencies between prolonged excessive crying and other behavioral and mental problems later in life. However, little is known about the association between typical or prolonged excessive crying and sleeping or eating disturbances in population samples.

In a cross-sectional study, the interdependencies between excessive crying and sleeping or eating disturbances were assessed in a representative sample of 1865 children aged 6 to 47 months at interview.

Methods

Questions on behavioral problems like excessive crying, sleeping disturbances, and feeding difficulties in children were added to the nationwide, random digit-dialing telephone interview to assess vaccination. This survey on children born between July 1, 1999, and June 30, 2003, was conducted between July 2002, and January 2004 by computer-assisted telephone interviews.

Informed consent was obtained from all participating parents. The response rate to the telephone survey was 62%. A total of 2827 interviews were completed. The analyses were confined to interviews carried out for chil-

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The response rate to the telephone survey was 62% for both surveys. Comparison with official data provided by the Federal Statistical Office revealed that data from telephone interviews were representative for families with age-eligible children in Germany with regard to geographic (Bundesland) and demographic factors (number of siblings, nationality, maternal age). Children from households with higher incomes were overrepresented (Table 1).

For 304 of 1865 children, the mothers reported crying or fussing for more than 3 hours a day on at least 3 days per week for more than 3 weeks, which accounts for a prevalence of excessive crying in the first 3 months of 16.3% (95% CI, 14.7-18.1).

Excessive crying was observed beyond the third month in 108 children. The duration of excessive crying was reported by the parents of 94 of these children. Excessive crying persisted at the time of interview in 14 of these children (observation period truncated at 24-42 months). Excessive crying waned during the first 6 months in most of the 108 children with excessive crying beyond the third month. However, persistence of crying for more than 6 months was reported in 47 (44%) of these children (Figure). The prevalence for excessive crying was 5.8% (95% CI, 4.8-6.9) beyond 3 months and 2.5% (95% CI; 1.9-3.3) beyond 6 months.

The prevalence of eating disorders was constant around 3% in the second, third, and fourth years of life compared with 1.4% in the first year. The prevalence of sleeping disorders, in contrast, decreased from the first to the fourth year of life (Table 2). In children with excessive crying limited to the first 3 months of life and those with prolonged excessive crying up to 6 months, the prevalence of poor sleeping and eating difficulties was not significantly higher than in children without any excessive crying. In children with excessive crying beyond 6 months, however, the prevalence of eating and sleeping difficulties increased dramatically (Table 3). Children with excessive crying beyond the first 6 months were 8.9 times more likely to have eating difficulties and 6.6 times more likely to have sleeping difficulties than those without excessive crying (Table 4).

Table 1. Demographics of the Study Population Compared With German Reference Data (Microcensus)\textsuperscript{12}

<table>
<thead>
<tr>
<th></th>
<th>Study Population, %</th>
<th>Microcensus, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>52.1</td>
<td>50.9</td>
</tr>
<tr>
<td>Female</td>
<td>47.9</td>
<td>49.1</td>
</tr>
<tr>
<td>Nationality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>German</td>
<td>93.0</td>
<td>90.4</td>
</tr>
<tr>
<td>Non-German</td>
<td></td>
<td>7.0</td>
</tr>
<tr>
<td>No. of siblings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>35.3</td>
<td>40.5</td>
</tr>
<tr>
<td>1</td>
<td>42.9</td>
<td>40.1</td>
</tr>
<tr>
<td>2</td>
<td>15.0</td>
<td>13.6</td>
</tr>
<tr>
<td>3</td>
<td>4.9</td>
<td>3.7</td>
</tr>
<tr>
<td>≥4</td>
<td>1.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Net household income, €</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1500</td>
<td>13.2</td>
<td>24.4</td>
</tr>
<tr>
<td>1500-3000</td>
<td></td>
<td>55.8</td>
</tr>
<tr>
<td>3000-5000</td>
<td></td>
<td>19.1</td>
</tr>
<tr>
<td>≥5000</td>
<td>4.6</td>
<td>2.9</td>
</tr>
<tr>
<td>Mean age of mother at birth, y</td>
<td></td>
<td>29.9</td>
</tr>
</tbody>
</table>

Figure. Children with excessive crying beyond the first 3 months of life (n=108); percentage of children with persistent crying at different ages.
This study is an extension of previous work and demonstrates that excessive crying does not always stop after the first 3 months of life. Among those with excessive crying beyond the first 3 months, 36% stopped crying within the first 6 months, but 44% continued to cry excessively. A significantly increased prevalence of eating and sleeping difficulties was observed only in children with excessive crying beyond the sixth month of life.

These findings are relevant for counseling parents and with respect to the interpretation of studies on long-term effects of excessive crying. However, these studies have given contradictory results; some studies have not found a relationship between excessive crying and sleep problems and other indicators of multiple regulatory problems,14-16 while others have found either sleeping or other regulatory problems.7,17-19 Some of these discrepancies may be owing to the studying of different groups of children, including children with typical colic only or those with colic and prolonged excessive crying. A recent study further underlined the differences in the prognostic value of classic excessive crying vs prolonged crying; children with prolonged crying (but not those with colic only) had an adjusted mean IQ that was 9 points lower than the control group.9

The fact that our survey was taken by a representative population sample strengthened our data. The response rates in this survey were similar to response rates in other telephone surveys conducted in Germany and the United States.20-22 The overrepresentation of children from households with higher incomes might potentially influence the observed association between excessive crying and sleeping or eating disturbances. In our data, however, income was not associated with crying, sleeping, or eating disturbances (data not shown).

The size of the study allowed us to look at the more severe spectrum of eating and sleeping disorders, although the numbers in the final categories were small and accounted for wide CIs. Since our main interest was to assess the relationship between these conditions and classic infantile colic, we focused on crying in the first 3 months and its extension beyond. A possible link to excessive crying starting after the first 3 months would be missed. Nine children with excessive crying beyond 6 months who fussed around at most or all meals additionally required distraction to be fed at all or most meals. Six children with excessive crying beyond 6 months who woke up on 5 or more days per week for at least 15 minutes were between the ages of 24 and 47 months at interview, which is an age when such poor sleeping is quite unusual. Identifying children with excessive crying in the first 3 months of life who may proceed to severe behavioral problems is one of the challenges in counseling parents of children with excessive crying.

Although some risk factors for excessive crying have been identified, such as maternal smoking during pregnancy,12,23 and cow’s milk allergy,24,25 the etiology of excessive infant crying is still poorly understood. The absence of a dose effect related to the duration of excessive crying was surprising. The few children with excessive crying and either severe sleeping or eating disorders might constitute a group of children with multiple regulatory problems outside the continuous spectrum of normal behavior.

The prevalence of any excessive crying was a bit higher in our study than in other retrospective studies. Prevalence estimates vary with the case definition used.3 The higher prevalence may have resulted from a slight modification of Wessel’s rule of three.3 We asked for crying or fussing longer than 3 hours per day, at least for 3 days per week, and for more than 3 weeks. Since there is no generally accepted case definition, any definition is acceptable as long as it is clearly stated.3 To test whether recall bias might affect the categorization of excessive crying, we checked the prevalence estimates for different categories of excessive crying by age at interview. The number of parents

### Table 2. Prevalence of Eating Difficulties and Poor Sleeping by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Eating Difficulties</th>
<th>Poor Sleeping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(95% CI)</td>
<td>(95% CI)</td>
</tr>
<tr>
<td>1 y</td>
<td>1.4 (0.7-2.2)</td>
<td>12.9 (6.1-23.0)</td>
</tr>
<tr>
<td>2 y</td>
<td>3.6 (2.2-5.3)</td>
<td>5.5 (3.8-7.6)</td>
</tr>
<tr>
<td>3 y</td>
<td>3.4 (2.3-4.8)</td>
<td>2.5 (1.6-3.8)</td>
</tr>
<tr>
<td>4 y</td>
<td>3.2 (1.6-5.6)</td>
<td>1.4 (0.5-3.3)</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.

### Table 3. Duration of Excessive Crying and Prevalence of Eating Difficulties and Poor Sleeping

<table>
<thead>
<tr>
<th>Duration of Excessive Crying</th>
<th>Difficulty Eating, No. (95% CI)</th>
<th>Poor Sleeping, No. (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never (n = 1561)</td>
<td>2.7 (1.9-3.6)</td>
<td>3.6 (2.7-4.6)</td>
</tr>
<tr>
<td>First 3 mo only (n = 196)</td>
<td>4.6 (2.1-8.5)</td>
<td>3.1 (1.1-6.5)</td>
</tr>
<tr>
<td>≤6 mo (n = 61)</td>
<td>3.3 (0.4-11.3)</td>
<td>1.6 (0.0-8.8)</td>
</tr>
<tr>
<td>&gt;6 mo (n = 47)</td>
<td>19.1 (9.1-33.3)</td>
<td>12.8 (4.8-25.7)</td>
</tr>
</tbody>
</table>

### Table 4. Association Between Duration of Excessive Crying and Prevalence of Eating Difficulties and Poor Sleeping

<table>
<thead>
<tr>
<th>Duration of Excessive Crying</th>
<th>Difficulty Eating, No. (95% CI)</th>
<th>Poor Sleeping, No. (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never (n = 1561)</td>
<td>1 (Baseline)</td>
<td>1 (Baseline)</td>
</tr>
<tr>
<td>First 3 mo only (n = 196)</td>
<td>1.7 (0.8-3.6)</td>
<td>0.9 (0.4-2.2)</td>
</tr>
<tr>
<td>≤6 mo (n = 61)</td>
<td>1.2 (0.3-5.2)</td>
<td>0.6 (0.1-4.1)</td>
</tr>
<tr>
<td>&gt;6 mo (n = 47)</td>
<td>8.9 (4.0-20.0)</td>
<td>6.6 (2.5-17.0)</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.

*Odds ratios with adjustment for age; reference, no excessive crying.
parents (interquartile range, week 1-3) matched the typical pattern. Parents' recall about crying in the first 3 months was not more common in children with multiple regulatory disorders would result in on overestimation of the proportion of children's excessive crying in the first 3 months. However, eating difficulties and poor sleeping were not more common in children with excessive crying limited to the first 3 months of life.

A further limitation of this study is its design; a cohort study might allow for a more valid estimation of the prevalence of excessive crying. We asked parents to remember the first 3 months first and then to report whether excessive crying extended beyond the first 3 months. Recall bias related to a selective recall of crying in the first 3 months in parents of children with multiple regulatory disorders would result in an overestimation of the proportion of children's excessive crying in the first 3 months. However, eating difficulties and poor sleeping were not more common in children with excessive crying limited to the first 3 months of life.

There are 2 further observations suggesting that the parents' recall about crying in the first 3 months was not grossly wrong. The onset of excessive crying stated by parents (interquartile range, week 1-3) matched the typical pattern. Parents might remember their child's crying in the first months of life less well when interviewed in later years of life (year 3-4 vs year 1-2). The remembered prevalence of crying, however, did not decrease with age at interview (data not shown).

We therefore feel that these limitations of the study design do not invalidate our findings. If excessive crying extends beyond the sixth month, the affected children have an increased risk for relevant eating and sleeping difficulties. Their parents should be offered support and counseling over a broader spectrum of features related to multiple regulatory problems.

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REFERENCES